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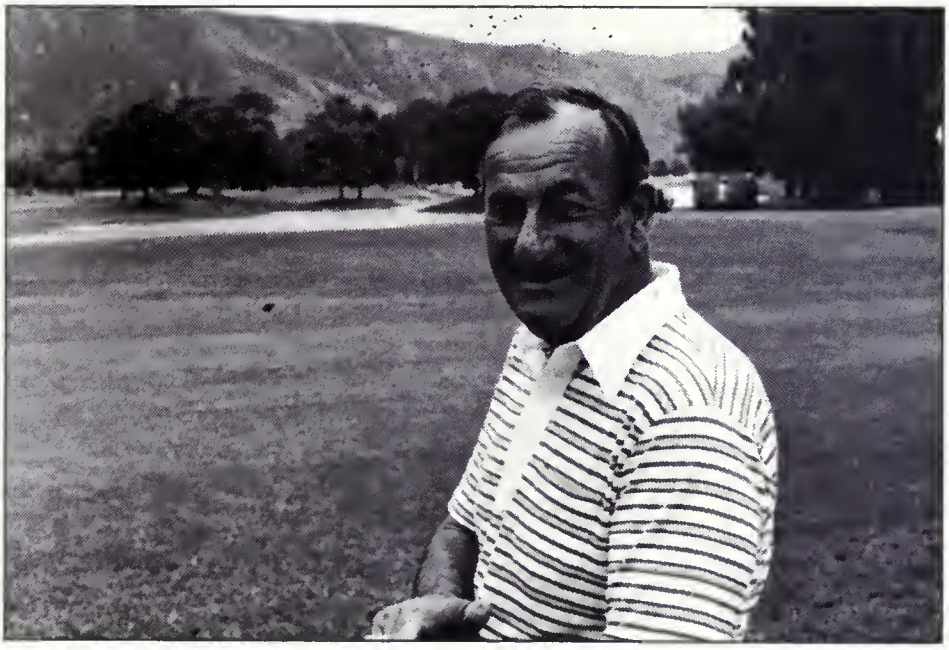
Western Mining in the Twentieth Century Oral History Series

Robert Eli Kendall

MINING BORAX, SHAFT-FREEZING IN POTASH MINES, U.S. BORAX, INC., 1954 TO 1988

With an Introduction by
Christian Hesse

Interviews Conducted by
Eleanor Swent
1992



Robert E. Kendall, 1979

Since 1954 the Regional Oral History Office has been interviewing leading participants in or well-placed witnesses to major events in the development of Northern California, the West, and the Nation. Oral history is a modern research technique involving an interviewee and an informed interviewer in spontaneous conversation. The taped record is transcribed, lightly edited for continuity and clarity, and reviewed by the interviewee. The resulting manuscript is typed in final form, indexed, bound with photographs and illustrative materials, and placed in The Bancroft Library at the University of California, Berkeley, and other research collections for scholarly use. Because it is primary material, oral history is not intended to present the final, verified, or complete narrative of events. It is a spoken account, offered by the interviewee in response to questioning, and as such it is reflective, partisan, deeply involved, and irreplaceable.

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Father Zeb Kendall: striking it rich in Tonopah, Nevada, 1900, and manipulating mining stocks; observations of the Cornish pump; converting underground mine to open pit mining, Boron, California; managing Allan Potash Mines, Saskatchewan, problems of shaft-freezing to mine below aquifer.

Introduction by Christian Hesse, Allan Potash Mines.

Interviewed in 1992 by Eleanor Swent for Western Mining in the Twentieth Century Oral History Series. The Regional Oral History Office, The Bancroft Library, University of California, Berkeley.

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PREFACE

The oral history series on Western Mining in the Twentieth Century documents the lives of leaders in mining, metallurgy, geology, education in the earth and materials sciences, mining law, and the pertinent government bodies. The field includes metal, non-metal, and industrial minerals, but not petroleum.

Mining has changed greatly in thia century: in the technology and technical education; in the organization of corporations; in the perception of the national strategic importance of minerals; in the labor movement; and in consideration of health and environmental effects of mining.

The idea of an oral history series to document these developments in twentieth century mining had been on the drawing board of the Regional Oral History Office for more than twenty years. The project finally got underway on January 25, 1986, when Mrs. Willa Baum, Mr. and Mrs. Philip Bradley, Professor and Mrs. Douglas Fuerstenau, Mr. and Mrs. Clifford Heimbucher, Mrs. Donald McLaughlin, and Mr. and Mrs. Langan Swent met at the Swent home to plan the project, and Professor Fuerstenau agreed to serve as Principal Investigator.

An advisory committee was selected which included representatives from the materials science and mineral engineering faculty and a professor of history of science at the University of California at Berkeley; a professor emeritus of history from the California Institute of Technology; and executives of mining companies.

We note with much regret the death of three members of the original advisory committee, all of whom were very much interested in the project. Rodman Paul, Professor Emeritus of History, California Institute of Technology, sent a hand-written note of encouragement just a few weeks before his death from cancer. Charles Meyer, Professor Emeritus of Geology, University of California at Berkeley, was not only an advisor but was also on the list of people to be interviewed, because of the significance of his recognition of the importance of plate tectonics in the genesis of copper deposits. His death in 1987 ended both roles. Langan Swent delighted in referring to himself as "chief technical advisor" to the series. He abetted the project from its beginning, directly with his wise counsel and store of information, and indirectly by his patience as the oral histories took more and more of his wife's time and attention. He completed the review of his own oral history transcript when he was in the hospital just before his death in 1992.

Thanks are due to other members of the advisory committee who have helped in selecting interviewees, suggesting research topics, and raising funds.

Unfortunately, by the time the project was organized several of the original list of interviewees were no longer available and others were in failing health; therefore, arrangements for interviews were begun even without established funding.

The project was presented to the San Francisco section of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) on "Old-timers Night," March 10, 1986, when Philip Read Bradley, Jr., was the speaker. This section and the Southern California section provided initial funding and organizational sponsorship.

The Northern and Southern California sections of the Woman's Auxiliary to the AIME (WAAIME), the California Mining Association, and the Mining and Metallurgical Society of America (MMSA) were early supporters. Several alumni of the University of California College of Engineering donated in response to a letter from Professor James Evans, the chairman of the Department of Materials Science and Mineral Engineering. Other individual and corporate donors are listed in the volumes. The project is ongoing, and funds continue to be sought.

Some members of the AIME, WAAIME, and MMSA have been particularly helpful: Ray Beebe, Katherine Bradley, Henry Colen, Ward Downey, David Huggins, John Kiely, Noel Kirshenbaum, and Cole McFarland.

The first five interviewees were all born in 1904 or earlier. Horace Albright, mining lawyer and president of United States Potash Company, was ninety-six years old when interviewed. Although brief, this interview will add another dimension to the many publications about a man known primarily as a conservationist.

James Boyd was director of the industry division of the military government of Germany after World War II, director of the U.S. Bureau of Mines, dean of the Colorado School of Mines, vice president of Kennecott Copper Corporation, president of Copper Range, and executive director of the National Commission on Materials Policy. He had reviewed the transcript of his lengthy oral history just before his death in November, 1987. In 1990, he was inducted into the National Mining Hall of Fame, Leadville, Colorado.

Philip Bradley, Jr., mining engineer, was a member of the California Mining Board for thirty-two years, most of them as chairman. He also founded the parent organization of the California Mining Association, as well as the Western Governors Mining Advisory Council. His uncle, Frederick Worthen Bradley, who figures in the oral history, was in the

first group inducted into the National Mining Hall of Fame, Leadville, Colorado, in 1988.

Frank McQuiston, metallurgist, vice president of Newmont Mining Corporation, died before his oral history was complete; thirteen hours of taped interviews with him were supplemented by three hours with his friend and associate, Robert Shoemaker.

Gordon Oakeshott, geologist, was president of the National Association of Geology Teachers and chief of the California Division of Mines and Geology.

These oral histories establish the framework for the series; subsequent oral histories amplify the basic themes.

Future researchers will turn to these oral histories to learn how decisions were made which led to changes in mining engineering education, corporate structures, and technology, as well as public policy regarding minerals. In addition, the interviews stimulate the deposit, by interviewees and others, of a number of documents, photographs, memoirs, and other materials related to twentieth century mining in the West. This collection is being added to The Bancroft Library's extensive holdings.

The Regional Oral History Office is under the direction of Willa Baum, division head, and under the administrative direction of The Bancroft Library.

Interviews were conducted by Malca Chall and Eleanor Swent.

Willa K. Baum, Division Head
Regional Oral History Office

Eleanor Swent, Project Director
Western Mining in the Twentieth Century Series

December 1993
Regional Oral History Office
University of California, Berkeley

Western Mining in the Twentieth Century Oral History Series
Interviews Completed, January 1994

Horace Albright, Mining Lawyer and Executive, U.S. Potash Company, U.S. Borax, 1933-1962, 1989

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James Boyd, Minerals and Critical Materials Management: Military and Government Administrator and Mining Executive, 1941-1987, 1988

Philip Read Bradley, Jr., A Mining Engineer in Alaska, Canada, the Western United States, Latin America, and Southeast Asia, 1988

Catherine C. Campbell, Ian and Catherine Campbell, Geologists: Teaching, Government Service, Editing, 1989

William Clark, Reporting on California's Gold Mines for the State Division of Mines and Geology, 1951-1979, 1993

James T. Curry, Sr., Metallurgist for Empire Star Mine and Newmont Exploration, 1932-1955; Plant Manager for Calaveras Cement Company, 1956-1975, 1990

J. Ward Downey, Mining and Construction Engineer, Industrial Management Consultant, 1936 to the 1990s, 1992

Hedley S. "Pete" Fowler, Mining Engineer in the Americas, India, and Africa, 1933-1983, 1992

James Mack Gerstley, Executive, U.S. Borax & Chemical Corporation; Trustee, Pomona College; Civic Leader, San Francisco Asian Art Museum, 1991

John F. Havard, Mining Engineer and Executive, 1935-1981, 1992

George Heikes, Mining Geologist on Four Continents, 1924-1974, 1992

Helen R. Henshaw, Recollections of Life with Paul Henshaw: Latin America, Homestake Mining Company, 1988

Lewis L. Huelsdonk, Manager of Gold and Chrome Mines, Spokesman for Gold Mining, 1935-1974, 1988

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Vincent D. Perry, A Half Century as Mining and Exploration Geologist with the Anaconda Company, 1991

Carl Randolph, Research Manager to President, U.S. Borax & Chemical Corporation, 1957-1986, 1992

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Joseph Rosenblatt, EIMCO, Pioneer in Underground Mining Machinery and Process Equipment, 1926-1963, 1992

Eugene David Smith, Working on the Twenty-Mule Team: Laborer to Vice President, U.S. Borax & Chemical Corporation, 1941-1989, 1993

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Homestake Mine workers: Wayne Harford, hoist operator; Kenneth Kinghorn, miner; Clarence Kravig, mine superintendent
Frank Joklik, Kennecott
John Livermore, geologist
McLaughlin Mine, model for resource development
Langan Swent, San Luis, Homestake, uranium mining

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INTRODUCTION--by Christian A. Heese

I first met Bob Kendall when I applied for the job of supervising the planning and construction of the potash mine shafts at Allan, Saskatchewan, Canada described in Bob's oral history. It was late October, 1961. Below-freezing weather had already seized the city of Saskatoon in its icy grip. As newly-appointed project manager of the U.S. Borax/Homestake/Swift Canadian Company joint venture formed to determine the feasibility of the Allan potash mine project some thirty miles to the east, Bob's first job was to put together a competent, on-site project team to handle the many technical challenges ahead.

And there were many! Up to that time, the sinking of several previous mine shafts had been attempted through the treacherous geological formations overlying the potash-bearing evaporite deposits some 3400 feet below surface. All had encountered heavy water inflows which resulted in shaft abandonment--in one case permanently. The most formidable barrier to accessing the rich potash beds below was the dreaded Blairmore formation, a 400-foot band containing unconsolidated siliceous sands and silts, with its top located over 1600 feet from surface. This formation is saturated with ancient brines at a pressure exceeding 600 pounds per square inch. Below that lies the Duperow formation, a layer of hard dolomitic limestones containing vugs and cavities also filled with high-pressure brine.

Because of the physical differences in these formations, two distinctly different water control techniques would have to be successfully applied. The chief obstacle to sinking operations was the Blairmore. If an excavating shaft bottom were to approach the Blairmore without measures preinstalled to staunch the flow, the high pressure brines would blow out the bottom and fill the shaft to within a few hundred feet of surface with an unpumpable sand slurry. The risk of loss of life and shaft equipment would be high.

By contrast, the dangers of the Duperow were more insidious and longer range. Excavation through the Duperow without prior water control measures would not be impossible, but brine leakage through the final concrete lining would continue indefinitely at a gradually increasing rate estimated in the hundreds of gallons per minute. The chemicals in the brine would quickly corrode the concrete shaft lining and the steel shaft installations, including the hoisting and guide ropes. Furthermore, the inflow of such quantities of unsaturated brine into the soluble salt shaft bottom and possibly the mine workings during operations could have disastrous results in a potash mine, as had been proven in Europe.

During my job interview, Bob explained these hazards precisely and fully. I had had thirteen years of experience in hardrock mining, shaft sinking, and tunnelling, and could readily appreciate the problems. Bob's description of the physical risks and the technical challenges, not only of shaft sinking but also of mine design and operation in the relatively unknown semi-plastic evaporite formations, caught my imagination. Bob also quickly impressed me with his technical competence, his obvious intelligence, and his open, easy personality. All of these qualities were wrapped up in an impressively burly, rough-hewn exterior. Here is a man, I thought, who will understand the problems, give guidance when needed, keep the bean counters off my back and give me enough rope to operate. It was also apparent that Bob's past as a practical miner and shift boss at Leadville, Colorado, and as a heavy constructor in Nevada would lend to his outlook a unique blend of the theoretical and the practical. Truly a miner's mining engineer. In spite of Saskatchewan's frigid climate, I quickly accepted the job.

Subsequently, the work of sinking two sixteen-foot diameter shafts to a depth of about 3600 feet was put out for bids by the world's foremost bad-ground shaft sinkers: Canadian, American, and European. To conquer the Blairmore and the Duperow, Bob and I selected a team of contractors which we felt had the most experience and the best proposed methods: Patrick Harrison and Company of Toronto for the hardrock portion of the shaft; and for the upper softrock portions, Associated Mining Construction, Ltd., a joint venture of four highly experienced German shaft sinking companies. These contractors agreed to join together to form a corporation known as AMC-Harrison (later succeeded by Thyssen Mining Construction of Canada) based in Regina, Saskatchewan. Water control methods chosen for the Blairmore included ground freezing from surface to below 2000 feet; and for the Duperow, high pressure cement and chemical grouting.

Allan No. 2 Shaft eventually became, in 1968, the first shaft sunk through these difficult formations without major water problems. However, our success was not unblemished. Bob's oral history describes the events following the late afternoon of February 11, 1966, when the Blairmore brines and sands started rushing into the unlined shaft wall just above the bottom of No. 1 Shaft at 1939 feet. Before many days had passed, the water level in the shaft stood at 230 feet from surface. It would be mid-October before we were to see the 1939 foot level again, but that is another story.

Throughout the shaft recovery period--marked by tense meetings of the joint venture owners, forceful confrontations with contractor personnel, seemingly endless meetings with insurance representatives, and a few notable blunders--Bob almost invariably kept his cool. How he managed this, in spite of separate problems with surface plant

construction, heavy outside responsibilities, and domestic commitments, I marvel at to this day.

I remember one particular occasion in the spring of 1966. AMC-Harrison had been searching desperately for ways to recover the shaft as quickly as possible. One scheme involved lowering a pattern of grout pipes through the water in the open shaft, to attempt to grout a plug of coarse aggregate and gravel which had been poured into the shaft after the accident to help support the unlined shaft wall. If a watertight plug could be grouted into place near the shaft bottom, the shaft could be pumped out without waiting for the ice wall breach to re-freeze, and several months time could be saved. The specifications for the grout pipe were exacting: the upper joints had to take the weight of almost 1900 feet of pipe suspended below. AMC-Harrison had located a supply of pipe which was thought suitable and Bob cautioned me to be sure they had carefully checked the pipe specifications before allowing them to buy it. I passed this message on and the pipe was duly purchased. About a week after delivery, I had a sheepish visit from Henry, AMC-Harrison's project manager; the pipe had been found to be inadequate after all! We both went to see Bob with the bad news--more time had been lost and about $30,000 had been spent. We were both expecting an explosion, but Bob merely grimaced. "Well, Henry," he said, "you knew what you had to buy. Now you've bought yourself some pipe. I don't care what you do with it, but don't use it here and don't expect to be reimbursed for it." That was the end of the matter--we were never billed for the pipe.

In his mastery of the severe challenges (not only the technical ones, but perhaps even more so the interpersonal ones) of the Allan Potash Project, Bob Kendall more than fulfilled my initial impression of his capability. He proved to be the best boss I had over a forty-two-year career and as he once pointed out, we continued to learn from each other throughout our long association. Truly a miner's engineer--I can pay him no higher compliment than that.

Christian A. Hesse, Principal
Hesse Associates

July 1993
Los Angeles, California

INTERVIEW HISTORY--by Eleanor Swent

Robert Kendall was selected for participation in the oral history series on Western Mining in the Twentieth Century because of his family connections to early mining in California and Nevada, as well as his own mining career. He was the first mining engineer to be president of U.S. Borax, one of California's most historic mining companies, which has for its symbol the twenty-mule teams crossing Death Valley.

The company, under its various names, is distinguished by its corporate sense of history and the longevity of its employees. Nationwide, American employees spend 2.6 years with one employer; U.S. Borax's employees average fifteen years. In 1968, U.S. Borax merged with the giant international corporation RTZ [Rio Tinto Zinc], with origins in Spanish mines dating back to Phoenician times.

U.S. Borax was one of the first corporations to support the oral history series on Western Mining in the Twentieth Century with an annual donation. Even before the series was organized, the first interview was with Horace Albright, then ninety-six years old, retired president of U.S. Potash Company, which merged with Pacific Coast Borax to form U.S. Borax. James Boyd, whose oral history was fourth in the series, was the son of "Captain" Julian Boyd, superintendent of the Pacific Coast Borax mines at Ryan. The oral history of James M. Gerstley, first president of U. S. Borax, entitled Executive, U. S. Borax & Chemical Corporation; Trustee, Pomona College; Civic Leader, San Francisco Asian Art Museum, was completed in 1990. It was followed by that of Carl Randolph, Research Manager to President, United States Borax & Chemical Corporation, 1957-1986, completed in 1992, and Eugene Smith, Working on the Twenty-Mule Team: Laborer to Vice President, US Borax & Chemical Corporation, 1941-1989, completed in 1993.

The oral histories of U.S. Borax personnel were facilitated by U. S. Borax President Ian White-Thomson and Vice President Clay Lorah. My research was aided by a tour of the mine and processing plant at Boron, California, where Dave Wheeler, Elgian Hurley, Jim Minette, Richard Walpole, and Frank Gonzales were very helpful. The state-of-the-art, emission-free mine and processing plant are a technological triumph as impressive in its way as the work going on at neighboring Edwards Air Base.

Kendall tells in his oral history of his father's arrival at Tonopah, Nevada, in 1900, broke, and getting a lease on the Mizpah vein which netted him $100,000 in ninety days. Zeb Kendall spent his life as a mining promoter and speculator, with a brokerage on the San Francisco Mining Exchange. He participated in all the central Nevada mining booms, served two terms as Nevada state senator, and from 1920 until his death in 1954 was president of the famed Consolidated Virginia Mining Company in Virginia City, Nevada.

It is not surprising that Bob Kendall expresses enjoyment of the romance of his profession as well as its technical challenges. He grew up alternately living in San Francisco and in Virginia City where boys played in abandoned mine workings and could still see the last of the old Cornish pumps. After attending Dartmouth College and serving in the army during World War II, he returned to graduate in mining engineering from Mackay School of Mines at the University of Nevada in Reno. He worked in Colorado and Nevada and then in 1954 was hired to work for six months on a feasibility study for U.S. Borax when they were considering converting the mine at Boron to an open pit. He stayed on to develop and operate this mine which won national awards for new development.

He then became project manager for U.S. Borax in Saskatchewan, Canada, at the Allan potash mines. Here, as in the Comstock, Nevada, district, the challenge was to contend with water underground. In Canada, the problem was solved with techniques developed in Germany for freezing the ground. As Kendall relates in his interview, this was dangerous and extremely difficult. In spite of initial failures, the mine was eventually successful, and Kendall was made vice president and subsequently president of the company. He still serves as a director.

He was interviewed at The Bancroft Library where he was doing some research on Cornish pumps. A planning session was held on 9 November 1992 and the interview was conducted on 10 November 1992. After the tapes were transcribed and lightly edited, he reviewed the transcript and returned it promptly. He made few changes, but two lively additions: the accounts of his father stealing the grain tithe and leaving Utah; and his mother throwing $80,000 of his father's gambling winnings out a hotel window.
This oral history contributes to the lore of Western mining, and also documents a technological development in contending with water underground.

The introduction is by Christian Hesse, Principal, Hesse Associates, who was planning and construction supervisor for the Allan Potash project.

The tapes of the interview are available for study at The Bancroft Library.

Eleanor Swent, Project Director
Western Mining in the Twentieth
Century Oral History Series

June 1993
Regional Oral History Office
The Bancroft Library

Regional Oral History Office
Room 486 The Bancroft Library

University of California
Berkeley, California 94720

BIOGRAPHICAL INFORMATION

(Please write clearly. Use black ink.)

Your full name Robert Eli Kendall

Date of birth Jan. 20, 1923 Birthplace San Francisco

Father's full name Zeb Kendall

Occupation Mine owner, operator, Promoter Birthplace St. Johns Kansas

Mother's full name Belle Frances Kendall, nee Pepper

Occupation Housewife, Singer Birthplace Montrose, Colo.

Your spouse Lillian Ruth Kendall, nee Anderson

Occupation Housewife Birthplace Huntsville, Ala.

Your children John, Robert E., Jr. James P., Ted, Mimi.

Where did you grow up? San Francisco and Virginia City, Nev.

Present community Rolling Hills Estates, CA. 90274

Education Dartmouth College (2 years)
B.S. in Mining Eng. 1948.
Mackay School of Mines, U. of Nevada-Reno (3½ yrs)

Occupation(s) Mine Engineer, Foreman, Superintendent Manager, General Manager, Vice Pres., President, Underground and open pit mining companies

Areas of expertise Mine planning and development
Mine operations, general management.

Other interests or activities General history, Western American mining history, collecting related books and documents. Volunteer service on various local boards & committees

Organizations in which you are active A.I.M.E., Cresta Palos Verdes Homeowners Assoc., Rolling Hills Country Club.

I FATHER ZEB KENDALL, FROM RAGGED MINER TO MILLIONAIRE

[Interview 1: November 10, 1992] ##[1]

Swent: We are interviewing today at the Bancroft Library under some difficulties because there is a mining operation going on outside our window. [laughs] They're putting in a new library facility underground, and Mr. Kendall being a mining engineer is at home with that noise, but the transcribers might find it a little troublesome.

Let's start with your background. You came from a mining background. Your father was Zeb Kendall, that's right?

Kendall: That's right. He was known throughout his life as Zeb. Born in 1876 in Kansas on a farm, and later moved to Utah with his family. My dad's father Eli was a strict Mormon. At harvest time, every tenth load of hay and grain went to the church warehouse in Provo as a tithing to the church. Around 1895 Dad and his older brother were hauling a wagonload of hay to the church warehouse when they began to feel sorry for themselves. Their clothes were ragged and their shoes were busted out. So, instead of delivering the hay to the church, they sold it for $10. And even worse, instead of buying clothes, they bought a bottle of whiskey and got drunk. When they sobered up, they didn't dare go back and face the old man, so they both ran away. Dad ended up as a day's pay miner and tramped around Utah and southern Nevada for a few years, earning $3 a day as a singlejack driller.

While he was in Mercur, Utah, working in the mines, he heard about Jim Butler's discovery of the rich silver lode in Tonopah, Nevada, in central Nevada. This was in 1900, and he hustled over there. He was one of the first men to arrive. I guess he had

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[1]## This symbol indicates a tape or tape segment has begun or ended. A guide to the tapes follows the transcript.

ten dollars in his pocket, but Butler had none--his partners who located the claims had no money or means to start mining. They were broke.

Mizpah Vein, Tonopah, Nevada

Kendall: So the way they did it is they parceled out the vein to a group of men who were there and just staked out hundred-foot lengths of the vein with a wooden stake and said, "There it is," and all these people were given ninety-day leases. They had ninety days to make their pot, and my father was very fortunate, because the particular portion of the Mizpah vein that he was granted on the lease outcropped on the surface, it was six feet wide, and assayed 400 ounces to the ton in silver.

Swent: Oh, gosh!

Kendall: So he and his partner in ninety days with pick and shovel hand-sacked the ore, had it shipped by wagon sixty miles to the nearest railroad, and then by rail to the smelter in the San Francisco Bay Area.

Swent: Was that the Selby Smelter then?

Kendall: Selby Smelter, yes.

The two of them each netted, after all costs and royalties, $100,000 each. That made them very wealthy men by the standards of those days. Would have put them in the millionaire class today easily. And from that moment on, he was transformed from a ragged miner into an entrepreneur. He went on from there, spent the rest of his life in Nevada and in San Francisco as a mining promoter, speculator, gambler, and never really changed. He made and lost two or three fortunes, considered money as something to play with, not to invest.

He had a good life. He didn't buy real estate, he wouldn't buy land. He grew up on a farm; he said, "I'll never buy land." He hated farming. He had an aversion to owning long-term investments. Everything he had was liquid, and he made and lost his fortune three or four times.

Swent: Would he pick up prospects and then sell them to other people?

Kendall: Yes. He was a broker and promoter; he had a brokerage office in the San Francisco Mining Exchange. During the Tonopah boom, he

was involved in several other mines, developing and buying and selling, and then when Goldfield was discovered sixty miles south of Tonopah in 1902, it was an extremely rich gold discovery--

Swent: Tonopah was silver?

Kendall: Silver.

January Lease, Goldfield, Nevada

Swent: And Goldfield was gold?

Kendall: Yes. Some of the ore in Goldfield ran $2,000 to $3,000 a ton--very rich. And right on the surface again. He was lucky that he again got another lease called the January lease from one of the original locators and made another pile of money, and shortly after that, he established himself as a broker and buyer and seller of mines and mining stock, which he did virtually all of his life.

He was involved in all the central Nevada mining booms--the Goldfield, Bullfrog, Rhyolite--half a dozen others, as they came and went with great frequency. Tonopah and Goldfield were very substantial mining districts, and they produced a lot of great wealth. The others were more or less flashes in the pan, but they came every six months, there was a new boom in Nevada, and 150 mining companies would spring up, stock would be printed and sold to the public, and six months later, the mining camp was no more. But the promoters made a lot of money selling stock.

Swent: Did he organize companies?

Kendall: Oh, yes. He was in the thick of that. Around 1908, I think, he was elected to the state senate at Nevada for Nye County, which is where Tonopah was located. He served two terms as state senator. We had two homes: one in San Francisco, and one in Virginia City, and we spent half the year in San Francisco and half the year in Virginia City as I grew up. So I'm a hybrid California-Nevadan.

II CONSOLIDATED VIRGINIA MINING COMPANY

Swent: He was first down in Tonopah and Goldfield. We haven't gotten him up to Virginia City yet.

Kendall: Oh, yes. That's right. He was at Tonopah--

Swent: He was elected for senator from the Tonopah area?

Kendall: Tonopah area, yes. And about 1920, he got interested in speculating in the Comstock Lode mining stocks, and bought a heavy position in the company--the old big bonanza firm of the Con Virginia Mining Company [Consolidated Virginia]. Apparently, he got suckered into buying that stock, because after he achieved control of the company, he found out the rumor of rich ore down there that they had supposedly discovered was very insignificant. But he was stuck with the stock, and he stayed with the company for the rest of his life. He made himself president of the company, since he controlled it, and was president of the Con Virginia Mining Company from 1920 to his death in 1954.

Manipulation of Mining Stocks

Swent: Who did he buy the stock from, do you know?

Kendall: He bought the stock from the San Francisco mining stockbrokers. I guess the blackest feature of the Comstock Lode's history is the way the stock was manipulated from the very earliest days, right to the end of the period when all the mines closed down in the 1930s.

The mines were owned by the general public as stockholders. But the individual stockholders were all small investors and speculators. When they bought stock, it was never issued in

their name. They left it with their broker, and the broker was the trustee. It was called "street stock."

So the brokers, the San Francisco brokers, had all of the stock in their names as trustees, and they elected themselves to the offices of the company. With very few exceptions, all of the thirty or forty mining companies in the Comstock had San Francisco brokers who really knew nothing about mining as officers of the company--president, secretary, treasurer. They did hire superintendents to run them. They all lived in San Francisco. And they lived off buying and selling stock, and making the stock rise, and making it fall. They would make a few bucks.

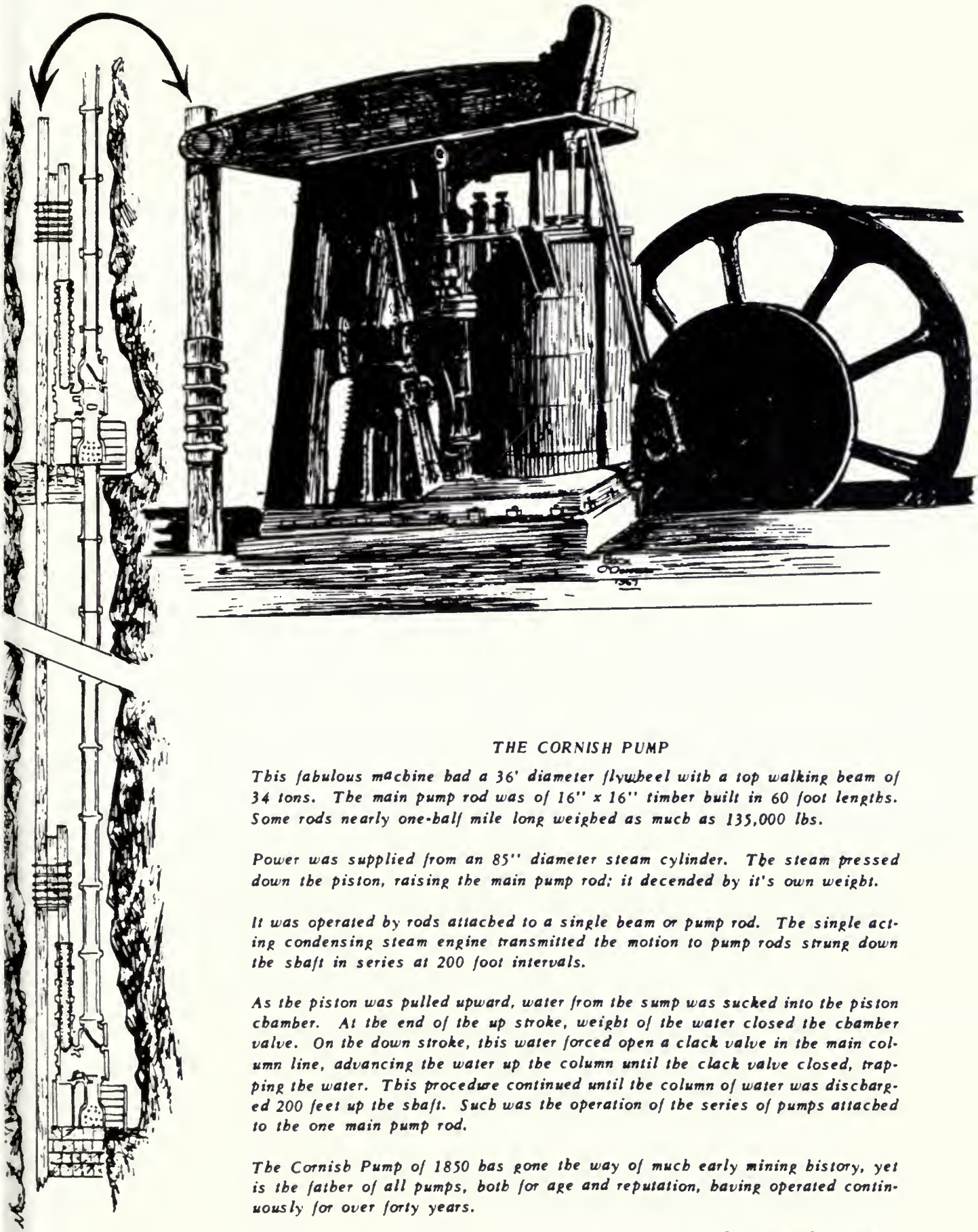
And they had all kinds of bad practices. If they wanted to sell, what they would do is they would start rumors of a rich strike underground, and keep the miners underground for a few days. Then they would get the speculators to buy. Of course, they'd sell their own stock to speculators, and make some money.

Once they had unloaded the stock, they'd do the reverse. They would issue gloomy reports about how bad things were, and the mines were about to flood, and they were thinking about closing them down. The stock would immediately drop, and then they'd buy it back up again at a low price. So they just jogged the stock up and down for sixty years.

It was a very egregious example of capitalism, and was very bad for the district itself, because in order to increase the play in stock, the district was subdivided into tiny little plots of ground. Every one was a corporation and a mine had a shaft on it, and its own pump, and of course you can see this was very inefficient. That camp would have lasted a lot longer and would have been much more successful had some of those very small mines been consolidated into one efficient mining group.

Swent: So even the Con Virginia, which was consolidated, was not big enough?

Kendall: Well, that's an interesting story. The Con Virginia was put together from five or six small mining claims by Mackay and Fair, the bonanza kings. But the minute they hit the big bonanza in 1873, they immediately split it into two companies--Consolidated Virginia and California--in order to have two companies to sell stock. So they divided--the big bonanza was divided right down the middle. Half if it belonged to the Con Virginia, and half of it belonged to the California. Same management, same ownership, same directors, same president, but two separate companies, simply for the purpose of doubling the play on the stock.



THE CORNISH PUMP

This fabulous machine had a 36' diameter flywheel with a top walking beam of 34 tons. The main pump rod was of 16" x 16" timber built in 60 foot lengths. Some rods nearly one-half mile long weighed as much as 135,000 lbs.

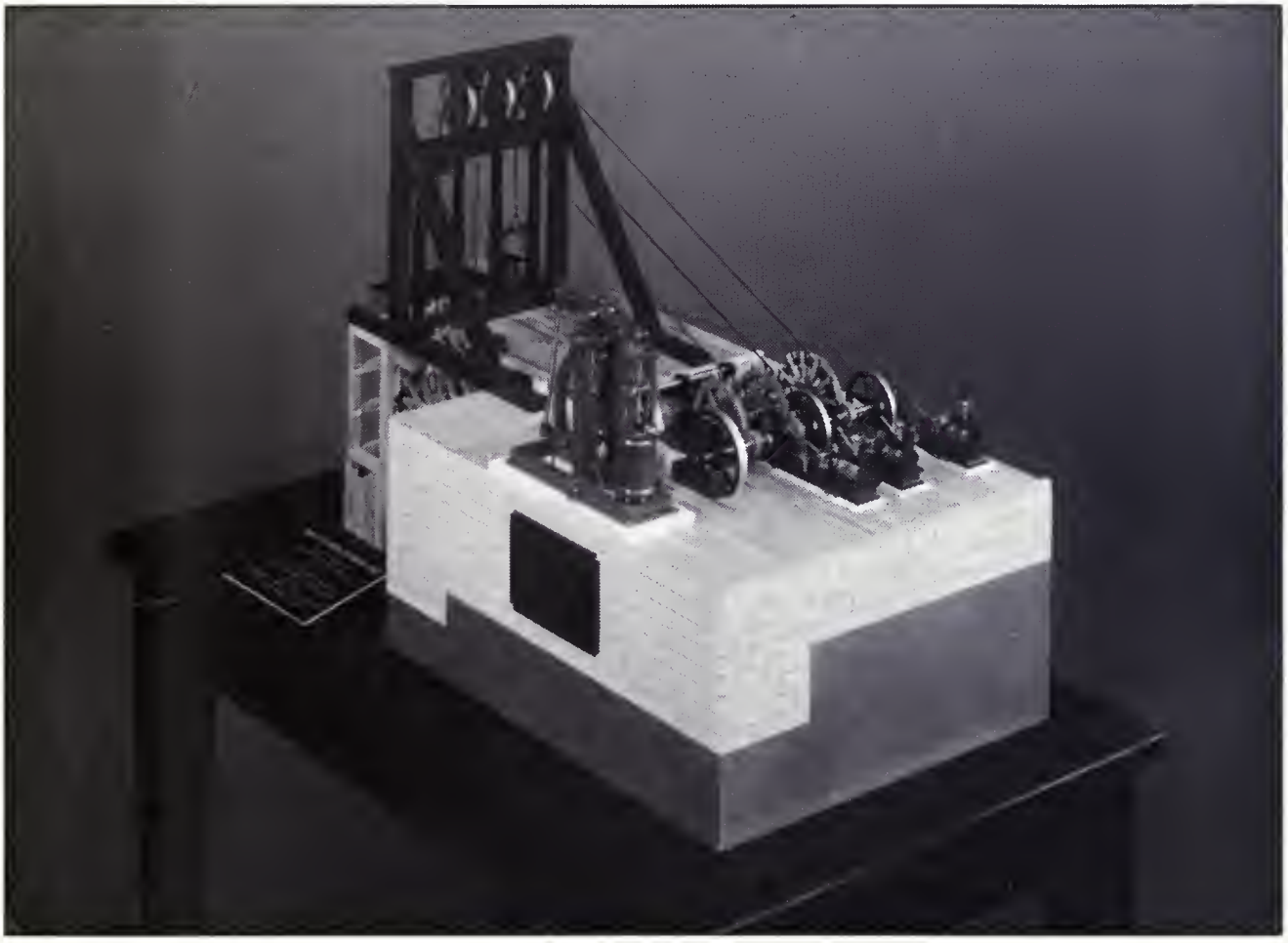
Power was supplied from an 85" diameter steam cylinder. The steam pressed down the piston, raising the main pump rod; it decended by it's own weight.

It was operated by rods attached to a single beam or pump rod. The single acting condensing steam engine transmitted the motion to pump rods strung down the shaft in series at 200 foot intervals.

As the piston was pulled upward, water from the sump was sucked into the piston chamber. At the end of the up stroke, weight of the water closed the chamber valve. On the down stroke, this water forced open a clack valve in the main column line, advancing the water up the column until the clack valve closed, trapping the water. This procedure continued until the column of water was discharged 200 feet up the shaft. Such was the operation of the series of pumps attached to the one main pump rod.

The Cornish Pump of 1850 has gone the way of much early mining history, yet is the father of all pumps, both for age and reputation, having operated continuously for over forty years.

Courtesy of J. Ward Downey



Model of the pumping and hoisting works of the Savage Mine, Virginia City, Nevada, 1866-1877. The 200 HP Corliss type beam engine operated Cornish pumps to a vertical depth of 2,100 feet. The beam engine flywheel was 19.5 feet in diameter. Bore 26 inches, stroke 72 inches. Built for Robert E. Kendall by David R. Harding in 1993. [see appendix for further information].

Photography courtesy of Robert E. Kendall

After the bonanza played out, and the production dwindled down, they recombined and put it back to one company. But that sort of thing went on all over the place.

Mining in Squeezing Ground, Very Hot and Wet

Swent: So efficiency of operation was not a consideration.

Kendall: No, it was not. Some of the mines had very able superintendents, and good engineers. Con Virginia among them, for that matter. And many technological developments came out of the difficulties in mining in Virginia City. The biggest problem--there were three big problems in mining in Virginia City. One, the ground was very heavy. It was soft clay, and what they call squeezing ground. Every foot of the way had to be heavily timbered.

Second, it was hot. Some of the hottest mines in the world were in Virginia City; it got very hot. When you get down below 500 or 600 feet in depth, the rock temperatures increased. And third, it was very wet. Huge quantities of water. In fact, the hottest water ever encountered in mines was encountered there, up to 145 degrees in temperature, in very large quantities. Now, this is the same temperature as comes out of your hot water heater, and you know when you touch that, it burns you.

Men worked underground under those conditions. They had to force a great deal of air down with rather primitive blowers and bring ice and ice water to the miners, and they had to pump enormous quantities of water. They developed ways to do that. The most interesting were the pumps, which is one of the things I am working on in this project.[1]

Cornish Pumps

Kendall: The pumps were called Cornish pumps, because they were developed--this type of steam pump was developed in Cornwall to dewater the great tin and copper mines there that flourished in the early to middle part of the 19th century. The Cornish engineers developed what they call a beam pumping engine. It's

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[1]Mr. Kendall came to The Bancroft Library to do research on Cornish pumps.

huge steam cylinders up to 100 inches in diameter, that actuated a series of wooden rods descending down the shaft. At the bottom of the shaft, the rods worked force pumps which pumped the water to the surface.

This technique of pumping was used on the Comstock and reached its greatest development there. Some of the largest steam engines ever built were constructed for the huge pumps of the Comstock in the [eighteen] seventies and eighties. In one case, one of the engines had a 40-foot-diameter fly wheel, which is the equivalent to a four-story building in size. Although it ran very slowly--six revolutions per minute--it developed 1,200 horsepower.

That pump actuated a series of wooden rods sixteen inches square that hung down the shaft for 2,000 feet. Over a million and a half pounds of rod, it had to move up and down six times a minute. The rod was connected to the pump plungers, which actually pumped the water into pipes, which brought it up to the surface.

Swent: It had no buckets.

Kendall: It wasn't a water wheel, no. It's an interesting thing. You see it so often in technology. Those pumps reached their climax in the seventies and early eighties in the Comstock, and they were beautiful, gorgeous machines. All built in San Francisco by local foundrymen, most of whom were immigrants from Scotland, Wales, and Cornwall.

Some of the great foundries in San Francisco--the Risdon Iron Works, the Union Iron Works, and the Fulton Foundry--all built steam hoists and Cornish pumps for the Comstock mines and for the Grass Valley mines, the Mother Lode mines, as well as steam engines for all the coastal vessels. Their history is intimately connected with the mining industry of the western United States.

The mines got so deep, after they reached 2,000 feet, the weight of the wooden rod that was suspended down the shaft was so great that it was almost impossible to design a machine that could move it up and down to actuate the pumps. At about that time, those old Cornish pumps were replaced by other means of pumping. At first it was the hydraulic pump, where they--

Swent: When was this changing over?

Kendall: In the 1880s.

Swent: So did you see any of the Cornish pumps actually still working?

Kendall: No, they were not working during my time.

Swent: But you did actually see them.

Kendall: Yes. I saw the largest Cornish pump ever built in the United States when I was a child, at the Union Shaft. This was the one with the 40-foot fly wheel and 100-inch-diameter steam cylinder.

They were rapidly replaced, however, when electric motors came in. Electricity was brought into the Comstock in the late 1880s. It became possible to place the pumps underground, rather than on the surface--the pumping mechanism. The reason the pumps, the machinery, always had to be on the surface was because when you had steam, you had to have boilers and fuel, and you just couldn't put a steam boiler and a steam engine in that hot underground atmosphere. It was hot enough.

So they had to put them on the surface, and run the pumps through these huge rods that were suspended down there. But as soon as they developed electrical motors and piston pumps driven by electric motors, they could place those underground and avoid all that huge weight of machinery on the surface and the rods, and by the early 1900s, many of the big Cornish pumps were still there, but they were idle. Over the years, they were all eventually broken up and sold for scrap, which is a shame, because it's too bad somebody didn't preserve at least one of them.

Swent: Not a single one was preserved?

Kendall: No. There are several actual Cornish pumps in Cornwall, they're still preserved.

Swent: Yes. I've seen one there.

Kendall: I'm going over there next year to take a look at one.

Swent: They're beautiful things.

Kendall: Yes. Mines were--my father's was like all the other mines in the Comstock, went ever and ever deeper. But the productive ore played out at about 1,700 or 1,800 feet in that district, and although they went down to the 3,000-foot level, they never found much paying ore. They found some ore, but not enough to pay for the enormous expense of development and pumping. So the history of the last forty years of the Comstock was ever and ever deeper, and ever and ever less profitable operations.

Finally, in the thirties, everything shut down.

Swent: Even before the war?

Kendall: Yes. Although my father pulled the pumps in the Con Virginia mine--I was five years old, and I remember that, I remember seeing him do it--in 1928. He let the deep underground workings flood, but then he went back to the surface and scratched around. And in the thirties, there was a pretty thriving small mining community on the Comstock Lode, leasers and companies remining the old surface ore, which was too low-grade in the early days to process. But there were half a dozen relatively small but profitable mining operations on the surface, and my father did that, and the Ophir Bonanza--

Swent: They were on the surface? Just open pit mines?

Kendall: On or near the surface. Some were open cut and some were underground. The Ophir Bonanza was the original discovery in 1859, and was very rich, and had been mined underground about three different times. They'd go through, they took the high-grade, and then they'd come back fifteen years later and get lower and lower grade ore. My father was the last one; he just dug out everything that was left with truck and shovel and put it through his mill.

Robert Kendall prospecting at the outcrop of the Ophir Bonanza, Virginia City, Nevada, 1949.

III ROBERT KENDALL, MINING ENGINEER

Childhood and Education

Swent: And you said that the workings in Virginia City were just open, and as a child you could play there?

Kendall: Yes. Where I grew up, our house was located right on the outcrop of the vein in the old Mexican claim, which is part of the Con Virginia group, right next to the Ophir Bonanza. There was an old ventilation shaft right in our back yard, and we used to crawl down in there and see the whole mine working, miles and miles of tunnel. Some very crooked, very small, but we'd find old tools and mining equipment that was left there, and miners' candles, and drill steel, and things like that.

Swent: You had flashlights or something that you went in with?

Kendall: Candles. Sometimes we had candles. Sometimes we used the little carbide lamps. They were still in use when I was a kid.

Swent: And nobody ever told you this was dangerous?

Kendall: We never told our parents we were doing that.

Swent: They didn't know you were doing it?

Kendall: No. [laughter]

Swent: Oh, my. You really think they didn't know?

Kendall: I guess they did. It was just--you grow up in a mining camp, you don't think about those things.

Swent: All the boys must have been doing it.

Kendall: Yes. Some of them wouldn't do it, but the gang I played with, we did it. We loved it.

Swent: Gosh. [laughs] So you went to school there?

Kendall: I went to grammar school alternately in San Francisco and Virginia City, and high school, too. I went to high school in both places.

Swent: How did that work?

Kendall: Well, the first two years I went to high school at Virginia City, but Virginia City was a small town. I think there were thirty-five students in our high school at that time, and they had no college preparatory classes, no foreign language, and very little math and science. I wanted to go to college, so my dad sent me to Montezuma School, a private school near Los Gatos, California, for my last two years. That allowed me to get prepared for college.

I went to Dartmouth College in 1940, majoring in physics. When the war came along, I went in the U.S. Army Air Force, and served in the 20th Air Force in Guam as a radar mechanic.

When I came out, I didn't go back to Dartmouth. I decided I wanted to get back into the mining business, so I finished my college education in the Mackay School of Mines in Reno, University of Nevada, and graduated in 1948 as a mining engineer.

New York Mine, Gold Hill, Nevada

Kendall: I went to work in a local mine in Gold Hill, Nevada, which is the southern part of the Comstock Lode. It was a small underground mine, and I learned--since I was the only mining engineer on the staff, I did everything--surveying, sampling, mapping, geological work--and I'd work with the miners when I wasn't busy as an engineer. So I learned how to drill and blast and set timber.

Resurrection Mine, Colorado

Kendall: That mine closed down two years later, and I went to Leadville, Colorado, and worked at an underground lead-zinc mine there under very difficult conditions.

Swent: That was the Resurrection--

Kendall: Resurrection Mine. That was a Newmont operation. I started out as a mining engineer.

Swent: How did you happen to get that job?

Kendall: I wrote Fred Searls. My father was a good friend of Fred Searls, who was president of Newmont. Jobs were hard to get. You really--I guess I applied at ten different places. I knew this mine was going to shut down. I wrote to Searls, and he was kind enough to suggest that I go to Leadville and see if I could get a job in that mine, and I did. Took a bus and rode to Leadville and got interviewed, and they hired me.

Swent: This was in 1950?

Kendall: Yes. Very shortly after I arrived, they made me general mine foreman. I was in charge of the underground operations there. But that mine had a short life expectancy also, as many mines do. I calculated we had about thirteen months of ore left, blocked out, and very little prospect of finding any more. I said as much to the general manager--

Swent: Who was the general manager?

Kendall: A man named Barney Greenlee. He didn't like what I said; he called that negative thinking. By that time, I was superintendent of the mine. He said, "I can't have a superintendent who thinks the mine's gonna shut down. What are we gonna do about it?"

I said, "Well, I guess the most sensible thing would be for you to find somebody else who believes it will run longer."

He said, "I think that's right. When can you leave?" And I left the next day. [laughter]

I came back to Nevada, to Virginia City. Incidentally, the mine did shut down in about fourteen months.

Swent: It did, so you were proved right.

Kendall: Yes. And I got back to Nevada in the midst of that--I guess it was 1952--that terrific snowstorm they had where the "City of San Francisco" was marooned, the train, for three days in the Sierra Nevada. They had 100 inches of snow in Virginia City, and I couldn't even get up to my house. I had to park the car a mile away and walk through drifts to get up to where my parents lived.

There were no jobs--everything was shut down. The winter was so severe that the whole area was paralyzed.

Finally, in the spring, I got a job with a contractor in Reno.

Open-Pit Stripping for Contractor C. V. Isbell

Kendall: I got a job with a mining contractor as an engineer, and I learned the open-pit mining business. Up to that time, I had been always underground, and loved working underground, and never thought I'd want to do anything else. But this contractor did development and stripping work, open-pit stripping work. He was a road builder originally, but he developed new open-pit mines for a number of big mining companies--Kennecott, ASARCO, Anaconda, and other companies--

Swent: What was his name?

Kendall: C. V. Isbell. He was a prominent man in Reno, and he kind of took a liking to me, and taught me the business. I worked at various open-pit development jobs for him.

Swent: Do you know what the C. and V. stand for?

Kendall: Nobody ever knew. He was always called "C.V." and nothing else.

Swent: Where did you work for him?

Kendall: Mostly Nevada, and some in California.

IV PACIFIC COAST BORAX COMPANY, U.S. BORAX & CHEMICAL CORPORATION

Kendall: In 1954, I was on vacation in Los Angeles, staying with my ex-college roommate, and he said, "Why don't you get a job with this company Pacific Coast Borax Company? They're expanding, and they're looking for people." I said I was on vacation, I wasn't interested, but he called them up and made an appointment for me, and loaned me his car. I drove to their downtown office and was interviewed, and they said, "Well, we need an engineer for six months to do a feasibility study. We've got an underground mine out in the desert, and we might want to convert it to an open pit. But we don't have anybody with open-pit experience. Can you do that?" and I said, "Yes."

They said, "We can promise you a six-months job. But if we decide after you make the study that we don't want to go to open pit, then we have no use for you, you'd have to go."

And I said, "Thank you very much," and I got up to leave.

They persuaded me to come back.

Swent: Who was interviewing you?

Kendall: This was Pat O'Brien, who was number-two man to Jim Gerstley at that time, the president.

Pat said, "Well, think it over some more." They were very secretive; they wouldn't tell me any details.

I said, "I don't want a six-months job. But I'm willing to talk if you will tell me more about the mine."

So they sent in another engineer. I said, "I've got a half an hour to make up my mind." He drew a picture of the orebody on

a piece of paper, just a plan and section, and told me how deep it was--

Swent: Who was this, do you remember?

Kendall: This was a fellow named Lynn Hersey, who was their consulting mining engineer and a specialist in underground mining. And in five minutes, I could see that that was a natural open pit, that they had been mining it the wrong way for thirty years, and that it should always been a--I took the job anyway. I figured I could make it go.

I did the feasibility study, and it turned out that they decided to go open pit, so I had a job.

Converting the Boron Deposit to Open-Pit Mining, 1954

Swent: Was this the mine at Boron?

Kendall: Yes. And when they made the decision to do that, I moved to Boron, and was responsible for all the planning and execution of developing that open-pit mine and putting it into operation. It was a very great experience for me. It was the first big job I had, and it was a great success. The mine won the national award for new mines that year, the first year of its operation. I had a lot of fun training underground miners to run trucks and shovels and bulldozers.

The mine plans that I laid out by hand the old-fashioned way in 1954 are still being essentially followed today. It is very gratifying to me to see that happen.

Swent: What kind of equipment were you using?

Kendall: We used electric power shovels and big trucks. Big in those days was 20-ton trucks and 3-cubic-yard shovels. Now in that same pit, which is still operating very strongly, we've got 22-cubic-yard shovels and 180-ton trucks.

Swent: Who manufactured them?

Kendall: The shovels--they're all made in the United States. Virtually all of the heavy mining equipment that's used all over the world is manufactured in the United States. Shovels are P&H shovels, and the trucks are made by a company called Unit Rig. They're 1,200-horsepower engines with electric motors in the wheel.

Improvements in Equipment

Swent: So the basic change was just that they became larger and larger?

Kendall: They became larger and more efficient, and I think the thing that has preserved the success of the big open-pit mines--costs today in money terms are probably lower than they were thirty years ago, in spite of the fact that there's been 400 or 500 percent inflation, because efficiency has kept pace with inflation. If it were not for that fact, a lot of the big copper mines and our borax mine would have been shut down years ago. But in real terms, costs keep going down.

Swent: Because you have fewer people operating, is that part of it?

Kendall: Fewer people, and labor efficiency goes up, and the equipment is bigger and heavier, and does more work per dollar.

Swent: How is this possible? Because it's made of better materials?

Kendall: Yes. Better engineering--in the trucks, it's an interesting thing that in the big trucks--a big truck when I started that pit in the fifties was a twenty-tonner. I guess about the largest size off-the-road truck was maybe thirty-five tons. And they were always limited by one thing or another. Either the engine was too small, or the tires couldn't handle the load, or the drive train, the transmission, and the gearing, wasn't strong enough to handle the engine.

They had a series of developments where they'd build a bigger engine, put it on a truck, promptly break the transmission. So then they'd work on the transmissions, and develop stronger transmissions. Once the transmission got strong, they'd put in a bigger engine, and they went back and forth until now we have trucks that will haul 200 tons in one load. That's a huge, big payload. And 25-, 30-cubic-yard shovels in one dipper.

So the development is still continuing, and it probably will continue.

Swent: It's amazing, isn't it?

Kendall: Yes. Later on, I got involved in--the other part of U.S. Borax's business--the potash business. They owned a large underground potash mine in Carlsbad, New Mexico, which was very old and was reaching the end of its economic life. Although there was plenty

of ore there left, it was high-cost ore, and they could see that within a few years, they'd have to shut it down.

V MANAGER, ALLAN POTASH MINES, SASKATCHEWAN, 1964-1968

Developing the Project

Kendall: So they went up to Canada, and staked claims in a new Saskatchewan potash district in central Saskatchewan. This huge resource was discovered accidentally by oil and gas drillers. Potash occurs in a salt bed about 3,000 feet deep, which is deeper than any potash had ever been mined in the world.

Nevertheless, it excited the interest worldwide, and a whole bunch of companies went up there and got leases from the government, as we did. I went up there in the late fifties as a project manager for our operation, moved my family to Saskatchewan. We drilled--

Swent: Was it called Allan at that time?

Kendall: We named it Allan Potash Mines because it was near the little farming village of Allan. We drilled a twenty-square-mile section of land that we controlled, and developed a very large reserve of potash ore, which is bedded ore in salt, potassium chloride, similar to salt, used as a fertilizer. I was responsible for doing the engineering feasibility study for that project, and we calculated the capital and operating cost to put the mine into operation.

Two years later, they decided to go ahead, and I was sent back to Saskatchewan as project manager. I was in charge of construction and building and startup of the operation.

It was a good-sized operation by anybody's standards. It was a 10,000-ton-a-day underground mine, and 3,500 feet deep, with a concentrating plant and all the other things associated with it on the surface. It had a capacity of a million and a half tons of finished product per year.

Mining Below the Blairmore Aquifer: Freezing the Ground

Kendall: It too had serious mining problems. Nobody had ever mined potash at that depth, and salt--potash is very similar to salt in appearance and strength. When salt is under great pressure, it won't stand up. It will flow like ice in a glacier. It deforms into what they call a plastic flow pattern.

So nobody knew whether you could keep a mine open at that depth. But we all were willing to gamble. To get to the potash, however, you had to sink through some of the wettest ground in the world. There was a formation called the Blairmore at 1,000 feet depth that was 500 feet thick, that was running quicksand, and was saturated with water. This Blairmore formation ran for hundreds of miles and was a huge aquifer, contained an unlimited amount of water. The first three shafts that were sunk through this ground all flooded. You couldn't hold the water back.

The option of pumping the shaft was not there. The volume of water was so great that no pump in the world could pump it out. So what you had to do was penetrate through this formation in either of two ways. Most of the ways first attempted were what they call grouting, where you get down close to this wet ground, and then you drill a whole series of drill holes, and inject cement into them, and turn the whole formation into concrete. And then you let it set, and then you sink through it, hoping that it won't break through.

In some cases it worked, and in some cases it didn't. A couple of times it did work; other times, the grout cover failed and the shafts flooded.

Swent: Were you doing this yourself, or were you contracting your drilling?

Kendall: We were the owners and operators, but we contracted all the construction out to specialists.

Swent: So they were sweating this out.

Kendall: Yes. We decided that grouting was too risky, and we did some research. We found out that in Germany, particularly in the German coal mines, which were very wet, they developed a technique they called shaft-freezing. The way they did it is they drilled a ring of drill holes, thirty-five or forty drill holes, around the periphery of the shaft site, and injected brine--refrigerated brine--into those holes, circulated it up and down for months, until the ground froze.

Swent: So what you had was really a ring that--

Kendall: You ended up with an icicle in the rock. Solid frozen ground. And then you sunk the shaft right down through the middle of that. It was an extremely expensive thing to do, but it appeared to be the safest thing to do, and that's what we did. We were sinking two shafts at the same time: one a service shaft, and the other a hoisting shaft. And of course, we needed two shafts for ventilation.

As you sunk the shaft through that wet ground, frozen ground I should say, immediately it was sealed up with huge cast-iron rings, four inches thick, of solid cast iron bolted together with lead gaskets to form a waterproof barrier. Once the ground thawed out, you had to have waterproof casing.

A Disastrous Flood

Kendall: We got down through the wet formation, but just below it we encountered a very weak section of ground, and the water broke through and flooded the shaft back up. We lost one of the shafts, and it took us nine months to recover it. We had to start up the refrigeration plant and refreeze the whole thing, and it cost a lot of money and was a very serious delay.

Swent: What was the date on this, do you remember?

Kendall: We started construction in 1964 and completed it four years later. It was a very long project.

Swent: So when that shaft broke through was about 1966?

Kendall: Yes, '66 I guess, something like that.

Swent: I remember some dismay around the place when that happened.

Kendall: Yes. Oh, there was consternation. Fortunately, the project was insured against flooding, and we got reimbursed for the direct damages and the repair costs.

Swent: Who does that kind of insurance?

Kendall: Oh, this was a very complicated insurance policy. It was the lead insurance agent--the lead group was Lloyds of London, and they layered it off in about seven or eight layers to insurance companies all over the world who took pieces of it. That's the

last time I think they ever insured any mining operations for flooding, because it cost them a lot of money.

Swent: It must have.

Kendall: Yes. Almost cost me my job, but not quite.

Swent: Were you held responsible?

Kendall: No, no. I expected that--usually when a disaster like that occurs, they pick somebody to blame it on. I figured it's got to be me; I'm the manager. I am responsible, and I took the responsibility. When they all assembled a couple of days later up there to assess the damage, I said, "Well, how long do you want me to hang around before you fire me for this terrible catastrophe?" and they said, "Not until you fix it." [laughter] They said, "Once you fix it, we'll think about that."

So we did fix it, and I didn't get fired anyway.

Swent: Was anybody hurt or killed?

Kendall: No. No injuries. Nobody--once the water started coming through, the shaft crew, which was a German-Canadian contractor, knew that was the end, so they got out of there fast.

Swent: They knew what was happening.

Kendall: The mine flooded from a depth of 1,500 feet--once the water started coming in, filled up to within 300 feet of the surface in about two hours.

Swent: Oh, my.

Kendall: Just gushed out of there. But they got out.

Swent: They were up above this--

Kendall: They were in the bottom of it.

Swent: But they were in that same shaft?

Kendall: They were in the same shaft, yes. But they had buckets, cages to get out.

Swent: And you were up there right on the site?

Kendall: Yes. It was a bad experience. But if you stay in mining long enough, something like that always happens. And that's not as

bad as killing people, or having fires or explosions. It just costs a lot of money. But it was a great education for me. There's no way you can take all the risk out of some construction jobs, especially mining.

It's interesting in comparison to the Comstock, where they had no choice but to pump the mines out. In Saskatchewan potash, you couldn't pump the mines out, because there was so much water, unlimited water. So what you had to do was seal it off. Fortunately, the water wasn't in the ore bed. It was above it. So if you could successfully drive your shaft through and seal it off, you could make it work.

Swent: This was a flat terrain, wasn't it?

Kendall: Yes. The surface was flat and the ore was a horizontal bed almost like a flat coal seam. We used continuous mining machines to grind up the ore and conveyors to convey it to the shaft. And those mines are still operating. Allan Potash Mine is still operating, quite successfully.

Swent: So did you come out within your estimate of your feasibility study?

Kendall: No. We overran it. [laughter] It was pioneering work, because there had been very little experience in that type of mining at that depth. Cost estimating was almost impossible.

Swent: Yes, I would think so.

Kendall: Anyway, once the mine got started up and was operating successfully, I was sent back to Los Angeles office as vice president of production.

Swent: So you weren't fired, you were promoted.

Kendall: That's right.

Swent: Good.

Kendall: And a couple of years later, I guess it was 1972, I was made executive vice president in charge of operations, and from that time until the time I became president, I was responsible for mining, manufacturing, engineering, research, and several headquarter staff functions.

Swent: Was Carl Randolph president?

Kendall: Yes.

Swent: And then you succeeded him?

Kendall: When he retired, I became president for a short time, a little over a year. I was getting close to sixty-four when Carl retired. So I served as president for a little longer than a year, and retired in 1988 when I reached sixty-five, but I'm still on the board of directors. Still have an association with the company, which I enjoy.

Swent: It's a great company.

Kendall: Yes. This is probably my last year. I think the bylaws of the company say you can't stand for reelection to the board after you're age seventy, and I'll be seventy next year, so that will be it for me.

But you add them all together, it's about forty years with the Borax Company, in a job where they told me I might last six months. The company was good to me, and I think I was good for the company, and I enjoyed it.

Swent: People work for that company for a long, long time, don't they, a lot of them?

VI THOUGHTS ON THE MINING INDUSTRY

Kendall: Yes. U.S. Borax had the unique advantage of owning one of the richest and most productive orebodies in the world, and that borax mine at Boron is a world-class orebody that stands out by itself. And that's what makes mining companies. You know, you could have the most brilliant management in the world, if you haven't got a good mine, you're not going to make any money. And even dummies can run a rich mine. We can't take credit for the success of the Borax Company. It's that orebody that takes the credit. And I believe that's true in most mines.

It's possible to make a difficult mine work and pay, and that takes brilliant management and hard work. But the old saying is, "Good mines make good reputations." [laughter]

Environmental Concerns

Swent: You might just say what you told me yesterday about flying over the desert, and seeing the mines there.

Kendall: Oh, yes.

Swent: Because Boron has been the focus of a lot of criticism.

Kendall: Yes. I've done a lot of flying in my business life, and I think I've identified every open-pit mine in the West, in Nevada and Utah and Arizona, by sight, because I've flown so many times and I know my geography. When you fly over the Western desert, you see hundreds of miles of uninhabited, virtually uninhabited desert, and you look down at a very large open-pit mine, and you see a little speck that covers maybe 100 to 200 acres, surrounded by miles and miles and miles of untroubled wilderness.

People--the public--is extremely agitated about this, and anytime anybody tries to start up a new mine, they cry they're going to ruin the environment. I could tell you, if you ever could get those people up in an airplane and show them what a small fraction of the space that these very important industrial enterprises occupy, and the impact is so little, I think they might change their minds.

They don't understand that the fundamental strength of this country is its natural resources. If we give up our basic industrial strength and stop producing from our natural resource base, we're going to decline. There's just no way we can maintain our wealth and power.

Swent: One of the criticisms is that it's not just the mine itself, but all the roads and support services that lead into it.

Kendall: Yes. There have been very bad cases of pollution in certain mines. The worst, of course, are the strip-coal mines in West Virginia and Kentucky. That's the model for everybody to criticize, and when someone thinks of a mine elsewhere, or a different kind of a mine, they still think of the strip-coal mine.

And that's not the case. It's possible to construct a mine nowadays and contain the effluents 100 percent, and they are doing that. As a matter of fact, you can't mine any other way. You've got a closed system.

Swent: You've done a terrific job out there at Boron.

Kendall: It costs a lot of money, but fortunately, we had the resources to do it. And we have zero discharge.

Swent: Both water and dust?

Kendall: Both water and dust, yes.

Swent: But your dust of course wasn't toxic anyway, was it?

Kendall: No, but it was visible, and a nuisance. But you can do it. You just have to spend money and use high technology. But you have no other choice now.

Swent: Would these companies have done that if they hadn't been just forced into it, do you think?

Kendall: It's hard to say. I think at a much slower pace. I have to admit that pressure generates change. I think industry in

general and the mining industry--they've come to terms with it, and accept it as a fact and as a desirable thing to do. What they don't want to do is get run out of business.

And there is a very strong and very powerful element on the fringe that would like to do just that, and that's part of their agenda. They want no activity whatsoever out there in the national forests and the public lands of the United States, where most of the mines are located. So it's a continuing battle to try and achieve a balance.

Swent: Yes, it is.

Safety in Borax Operations ##

Swent: Are there any particular safety considerations in your open-pit mine?

Kendall: The problem with borax is that there isn't any huge reservoir of knowledge because there are so few borax mines. The effect of borax dust on humans was not very well known. There were some studies that showed that borax--boron--could cause cancer in animals. These studies were done in Russia back in the 1950s.

To settle all doubts, the company contracted for a long-term, comprehensive epidemiological study of the population of workers at Boron going back many years. This study has just been concluded, and they found no evidence of adverse health effects with long-term exposure to borax, which makes us feel very good.

Swent: That's a relief, isn't it.

Kendall: Yes. It's soluble in the body and it's just expelled out in the urine, I think is the way it goes. You breathe it in, it goes right back out. It's like salt.

The Boron operation has been in the last few years a very safe operation. In fact, it won the National Sentinels of Safety award about five years ago, in my last year as president.

Swent: And what's in the water? Anything that would be a hazard?

Kendall: No. No, the water's okay.

Swent: So it was a good six-months job?

Kendall: Yes.

Swent: You were the general manager at the Carlsbad plant for a while, too?

Kendall: Yes. After we completed the engineering feasibility study, Borax and Homestake, the two partners in the venture, decided--they couldn't make up their minds. They put the project on hold.

Swent: This is the Allan project.

Kendall: The Allan project. So they sent me down to Carlsbad, and I ran that operation for two years. When they decided in 1964 to go ahead with the Canadian project, they sent me back up to Canada. So I lived up there twice with that project.

VII MOTHER, BELLE OF TONOPAH

Swent: You have not mentioned your mother. Please tell about her.

Kendall: Her name was Arabella Frances Kendall, but everybody called her Belle. She was born in a stone cabin in Montrose County, Colorado, in I think it was 1885 or '86. Her father ran a portable sawmill; it was all packed in wagons. He was a mountain man from Tennessee that had come West and spent most of his life on the western slope of the Colorado Rockies cutting timber for the mines. He would go from town to town with his wagon train and set up a little sawmill and cut timber. She was born in one of those camps.

Later on, my grandmother and my grandfather split, and he left my grandma and started another family. The girls went to Eureka, Nevada, to live with their grandmother on the mother's side. She was Swiss, born in Bern, Switzerland, and my great-granny was married to a butcher in Eureka, owned a butcher shop. The girls grew up there. The boys went with the father, and the girls went with the mother.

At the time, when Tonopah boomed in 1900, Eureka was a pretty dead town. It was a mining camp on its last legs. Her mother and her grandmother moved to Tonopah. Great-grandma was a seamstress, and she sewed clothes for a living, made clothes.

My grandmother worked also, and when Belle was sixteen years old, she was elected queen of the big celebration--Railroad Day--in 1904. The railroad finally came through Tonopah and of course it was the biggest occasion in the history of the town. She poured the champagne on the silver spike that was driven at Tonopah, and a couple of years later married my dad.

Swent: How did she happen to get elected queen?

Kendall: Well, I asked her that when I was a young kid. I said, "You must have been real pretty in order to win queen of that celebration."

She said, "Well, that wasn't necessarily what caused it." She said in those days, to become queen, the adherents of each candidate had to buy tickets, and the one who sold the most tickets was queen. She said, "Your father was courting me at the time, and he bought more tickets than anybody else, and that's how I became queen." [laughter]

Swent: So he married the queen of Tonopah.

Kendall: Yes, that's right.

Swent: That's a wonderful story. I like that. What else; is there anything else that you'd like to get in here?

Kendall: Well, there is a story my mother told me that's probably worth repeating. Dad loved to gamble, and did so all his life--poker, roulette, faro, stocks--anything that involved a risk. My mom repeatedly tried to get him to stop, and once she got him to swear off gambling for good. Shortly after, they were staying at the St. Francis Hotel in San Francisco where Dad ran into his old friend Wyatt Earp, the Tombstone gunman who later drifted to Goldfield and then to San Francisco. By that time he was wearing a business suit and selling real estate, but he had a passion for gambling like my father.

After a couple of drinks together they took off for the racetrack to "test" Dad's pledge, and stayed four days. When Dad got back to the hotel, Mom was waiting for him in the room. He threw a satchel full of winnings on the bed and said, "This is all for you." Without a word, my mother picked up the satchel, walked to the window, and emptied it out into the street. It turned out that the satchel had about $80,000 in winnings in it. I asked Mom if she knew that. "No," she said, "but I do know that it almost started a riot in the street."

VIII RESEARCHING CORNISH PUMPS; THE BANCROFT LIBRARY

Kendall: I guess I'd like to just say that since my father and I were both involved in all this wet mining and wet ground, one of my hobbies and delights in my later days, right now, is doing research on the ways that miners contended with water. The reason I'm here is that The Bancroft Library has been looking up old references and material on early day steam pumps for dewatering the mines. It's a great recreation for me to get involved in this sort of stuff.

Swent: Well, you're not just reading about them, you want the actual working drawings, don't you?

Kendall: Yes. I did find some actual designs of a very beautiful old Cornish-type pump installed in the Savage Mine in 1866. My intention is to turn it over to a model-maker and have an engineered model made of this pump, a working model, and ultimately donate it to the Mackay School of Mines Museum in Reno or the Fourth Ward School Museum in Virginia City. So I'm right in the middle of this project now; it's a lot of fun.

Swent: Yes. You said you found a wonderful craftsman in Ojai.

Kendall: Yes, there's a man who makes museum-quality steam engines and almost anything you want. He's a machinist and a mechanical engineer, and he's a brilliant craftsman.

Swent: His name is Harding?

Kendall: David Harding. I hope to get started on this in the next month or two.

Swent: Well, I hope you can.

Kendall: I'm satisfied I have the material now, and the background information.

Swent: You've got the specifications that you need.

Kendall: Got the specifications, got a lot of technical literature on the way those old steam pumps worked, got photographs of the actual mine it was in. And I researched the history, looked up the annual reports of the mine and found out when it was installed, and a lot of the details of it in the last two days. So I'm well equipped to start now.

Swent: Good. Well, that's great.

Kendall: I can't get over the enormous resource you have here in The Bancroft Library. It's impressive.

Swent: It is, isn't it?

Kendall: It really is something. Nothing like it anywhere else around here.

Swent: We'll be glad to add your tapes to it, too, because you've covered a lot of really interesting things here, and I'm grateful to you for sharing it with us.

Transcriber: Shannon Page
Final Typist: Shannon Page

TAPE GUIDE--Robert Eli Kendall

THE PUMPING AND HOISTING WORKS OF THE SAVAGE MINE

VIRGINIA CITY, NEVADA

The Savage Gold and Silver Mining Company owned 771 feet of ground along the strike of the Comstock Lode, in Virginia City, Nevada. The mine was situated near the center of town, and the shaft on E Street was two blocks east of the main street of the city. The shaft at various times was called the New shaft, the Curtis shaft (after Capt. Sam Curtis, an early Superintendent), and the E Street shaft.

Although the Comstock was discovered in 1859, the Savage found little or no ore until the Gould and Curry bonanza, to the north was found to extend into the Savage ground. From 1863 to 1874 the Savage was one of the big producers on the Comstock, producing 454,000 tons of ore, yielding $16,000,000 in bullion. Although no paying ore of consequence was found below the 1,400 foot level, the mine continued to explore ever deeper, and reached an ultimate depth of 2,800 feet.

As was typical of most Comstock mines, the Savage was a very wet, hot mine, and the beam pumping engine and the Cornish pumps which it operated were essential to keeping the mine dry enough to work.

The engine depicted in the model was installed in 1866 and operated until 1877, when it was replaced by a more powerful compound, differential, direct acting engine. However, the old engine did not die; it was dismantled and moved to a quartz mill on the Carson River where it served well for many more years.

The following description of the beam engine, pumps, and hoisting apparatus is taken from Volume III of the USGS Exploration of the 40th. Parallel, by James D. Hague, 1870.

> The pumping engine of the Savage mine is one of the Corliss pattern; a beam engine with a vertical cylinder, 26 inches in diameter and 6 feet in stroke, a very beautiful and efficient but costly machine. On the crankshaft is a pinion, 3 feet in diameter, which drives the main wheel, 10 feet in diameter, carrying the pitman by which the balance bob and the connected pump rod are set in motion.....The pump rod makes a stroke of 7 feet, under ordinary circumstances, about 4 times a minute, though capable of much higher speeds.

> The bob is of wrought and cast iron combined. The pump rod is made of pine, in sections 30 feet long and 12 inches square.....the weight of the rod, with it's iron straps, is partly balanced by the counter-weight on the bob at the surface, besides which there are three balance bobs at stations below ground.
>
> There are three horizontal, non-condensing hoisting engines, one for each hoisting compartment of the shaft. The engines have 16 inch cylinders with a 3 foot stroke, and are fitted with slide valves, link motion, and reversing gear. Average hoisting speed is 400 feet per minute.
>
> The hoisting cable is made of steel wire. It is flat, 4 1/5 inches wide by 3/8 of an inch thick.

The beam engine and pumps dewatered the mine to a vertical depth of 2,100 feet. The first 1,000 feet of the shaft was vertical, at which depth it intersected the main vein. At this point the shaft was inclined to follow the vein down to the east on a 38 degree slope.

The Savage struck a flow of hot water in 1876 on the 2,200 foot level that flooded the mine and the adjacent Hale and Norcross mine to the 1,800 foot level. Both mines remained flooded in their lower levels for three years, despite continuous pumping, until a connection was made with the Combination shaft on the 2,000 foot level in 1879.

The Savage ground was so wet that it was not sunk below the 2,800 foot level. Three separate crosscuts from the Combination shaft on the 2,500, 3,000, and 3,100 foot levels had to be stopped and bulkheaded, so great was the flow of hot water.

THE MODEL:

The model is constructed to a scale of 3/8 inch to 1 foot (1:32) from plans and descriptions published in the US Geological Survey Exploration of the 40th. Parallel Survey, Voloume III, by James D. Hague, 1870. Details of the beam engine valve gear were taken from George Corliss's 1849 US patent drawings.

The model was commissioned by Robert E. Kendall and was built in 1993 by David R. Harding .

CONTEMPORARY REFERENCES:

Savage Mining Company Annual Reports:

July, 1866: The Curtis, or E Street shaft, with four compartments 5 feet by 6 feet each, has been sunk to 470 feet.

At this shaft there are three engines. A Corliss beam engine, twenty six inch cylinder, is on it's way over the mountains. This last engine is not needed at this time, nor should the expense of building it have been incurred at the time it was. The three engines possess all the power to do all the work the mine will demand for a long time to come. However, as this engine was built, and the cost, which was a heavy burden on the Company, had to be provided for, it became necessary to make disposition of it. An effort was made to sell it, but not meeting an opportunity except at great loss, it was considered best to send it to the mine. With this engine, and the three before mentioned, we will have facilities to sink and explore our mining ground for many years.

July, 1871: The main shaft is now sunk into the west wall 66 feet. (1,000 vertical feet). In sinking it deeper, it will be necessary to do so by an incline, at an angle of thirty eight degrees to correspond to the dip of the west wall of the lode. The work should be commenced at once, and be continued without cessation, as the future of the mine must be determined by reaching a greater depth.....On the whole, the mine may be said, so far as can be seen, to be exhausted of ore of a paying value. By sinking deeper, new bodies of ore may be exposed, but until such bodies are found, profit from the mine cannot be consistently looked for.

July, 1874: The main shaft has been sunk to the 2,100 foot level. The power of the pumping and hoisting engines have been fully equal to the requirements of our deep working, and is quite sufficient for sinking and opening another 100 feet deeper. The large beam engine, which is used exclusively for pumping, has sufficient power to drain the mine of water at a much greater depth than has yet been reached. But for the purposes of sinking below a 2,100 foot level and hoisting from below that depth, it will be necessary to have one additional engine at the surface,or to provide some intermediate power placed underground.

"Pumping and Hoisting Works for Gold and Silver Mines",
By Joseph Moore and George W. Dickie, Risdon Iron Works,
San Francisco, California, 1877.

The best of the old pumping engines, that of the Savage mine, a fine beam engine of two hundred horsepower, geared five to one, driving a line of plunger pumps to a depth of 1,800feet, is at present being removed to give place to a compound differential direct acting engine. The old engine, which is still a fine specimen, is to be re-erected to drive the machinery of a quartz mill.

INDEX--Robert Eli Kendall

Eleanor Herz Swent

Born in Lead, South Dakota, where her father became chief metallurgist for the Homestake Mining Company. Her mother was a high school geology teacher before marriage.

Attended schools in Lead, South Dakota, Dana Hall School, and Wellesley College, Massachusetts. Phi Beta Kappa. M.A. in English, University of Denver. Assistant to the President, Elmira College, New York. Married to Langan Waterman Swent, mining engineer.

Since marriage has lived in Tayoltita, Durango, Mexico; Lead, South Dakota; Grants, New Mexico; Piedmont, California.

Teacher of English as a Second Language to adults in the Oakland, California public schools. Author of an independent oral history project, Newcomers to the East Bay, interviews with Asian refugees and immigrants. Oral historian for the Oakland Neighborhood History Project.

Interviewer, Regional Oral History Office since 1985, specializing in mining history.